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REPORT ON THE INVESTIGATION OF POLLUTION
IN THE BEAR RIVER SYSTEM, IDAHO - UTAH.
AUGUST AND NOVEMBER 1954

Public Health Service
Portland, Oregon

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BEAR RIVER SYSTEM

Idaho - Utah

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INTRODUCTION

In October 1952 the U. S. Public Health Service, under provisions of Public Law 845 (80th Congress), prepared a "Report on Interstate Pollution in the Bear River Watershed," with the assistance of the Wyoming, Idaho, and Utah state water pollution control authorities. Included in this report was a description of the area and waters involved, data on stream flows, water uses, pollution contributed, effects of pollution, and a discussion of the existing authority of the States of Wyoming, Idaho, and Utah for enforcement of pollution control. → P-4

The principal pollution of interstate waters occurs on the Cub River and its tributary, Worm Creek. Worm Creek receives partially treated sanitary wastes from Preston, Idaho, and untreated beet sugar refinery wastes from Franklin Sugar Company at Whitney, Idaho, near Preston. Cub River receives untreated vegetable cannery wastes from the plant of the California Packing Corporation at Franklin, Idaho, just a mile upstream from the Idaho-Utah state line. These streams join after flowing a short distance separately in northern Utah, and the Cub joins the Bear from the east ten river miles below the Idaho-Utah state line.

The report of the Public Health Service also included some cursory observations on effect of pollution by erosion silt and a brief discussion of the fisheries. With regard to the fisheries, it was indicated that the lower Bear is used principally for "rough" fishing: channel catfish and carp. Downstream from the Idaho-Utah state line a few rainbow

and brown trout have been found in recent years, but the sharp decline of the sport fishery over the past 20 years has been attributed largely to the heavy burden of silt which is carried by the Bear and deposited in pools and riffles.

In November of 1953 an extensive "fish-kill" in the lower Bear River was attributed to the detrimental effect of beet sugar mill wastes from the refinery at Garland, Utah. At that time a combination of circumstances brought about complete exhaustion of dissolved oxygen over a large flowing segment of the lower Malad River and the Bear River and virtually destroyed a valuable channel cat fishery as well as some marketable carp. The Utah Department of Fish and Game investigated the situation as it progressed and has prepared a report of its findings. The department conservatively estimated the loss in the one "fish-kill" at \$10,000.

Since the enactment of comprehensive water pollution control legislation by the State of Utah in 1953, steps have been taken by the Utah Department of Public Health to determine the extent and effect of pollution from industrial and sanitary waste sources. The State of Idaho, Department of Public Health, has cooperated in a study of the interstate problem of the Bear River System, and together the two states have undertaken a series of surveys to determine volumes and strengths of the various wastes discharged and their effect upon the receiving streams. The biological investigations were undertaken in order to provide information on the effect of pollution upon the aquatic life including algae, aquatic plants, fish and fish-food organisms. The findings are utilized to detect and measure pollution during the vegetable canning season in August and again during the season of beet sugar refining in

November. The effects of heavy siltation in the Bear River upon the capacity of this stream for natural purification of wastes and upon fish and fish-food organisms are also discussed.

The field surveys were conducted by Biologist John N. Wilson and Sanitary Engineer William B. Schreeder. Dr. Arden R. Gaufin, Professor of Zoology, University of Utah, provided valuable assistance on the earlier survey, which is gratefully acknowledged. In conjunction with the second survey of November 1954, the Utah Department of Fish and Game conducted a fish population study in the Utah portion of the Bear River. Mr. Marion Madsen, Chief of Fisheries Division, State of Utah Department of Fish and Game, detailed Mr. William McConnell, Field Projects leader, and his associates Messrs. Neuhold and Clark to participate in the investigation.

the report is
SUMMARY AND CONCLUSIONS

1. The results of two investigations involving the interstate waters of the lower Bear River Basin in Idaho and Utah are presented. The sections of streams under study included the lower ninety-two miles of the Bear River, the lower twenty to twenty-five miles of Malad and Cub Rivers, and the lower nineteen miles of Worm Creek, tributary to the Cub.
2. Both of the investigations were at times of low flow in the streams. The earlier, from August 8-17, 1954, was at the time of bean pack at the California Packing Company, Franklin, Idaho, on the Cub River just upstream from Idaho-Utah state line; and the later study of November 8-12 was made while the three sugar refineries, Franklin Sugar Co., Whitney, Idaho; Amalgamated Sugar Co., Lewiston, Utah; and Utah and Idaho Sugar Co., Garland, Utah; were in operation.
3. A critical situation of erosion on tributaries west of Preston has caused heavy siltation in the bed of the Bear River for many miles downstream. Bottom scouring, filling of pools and smothering of riffles have been responsible to a great extent for deterioration of the trout fishery over the past thirty years. Steps have been taken to correct the situation.
4. Sources of organic pollution are many and the aggregate BOD loading in the form of industrial wastes discharged to the receiving waters is thirty times that of the municipal sanitary wastes. Less than half of the total sewered population in the basin of the Lower Bear has adequate treatment for its wastes. Ninety-two percent of the industrial wastes are from sugar refineries, 7.5 percent from two vegetable canneries, and the remainder from cheese factories, meat packing establishments and the like.

5. These streams drain areas with calcareous deposits and are therefore high in alkalinity. The Bear River at B-92 and the Malad River have extremely high alkalinity--more than 300 ppm--the Cub River and Worm Creek have lower alkalinity. From the standpoint of turbidity from inorganic causes, the Cub was the clearest, the lower Bear and the Malad the most turbid. Turbidity in Cutler reservoir and in the lower Bear in August was caused partially by phytoplankton.

6. In August, dissolved oxygen concentrations under 5 ppm were found below the cannery at Franklin, Idaho, on the Cub River. In November, depletion of dissolved oxygen was found in the lowermost ten miles of Cub River and the lower five to six miles of Worm Creek. Although low water temperatures delay decomposition of sugar mill wastes along the main stem of the Bear, dilution was not sufficient to forestall an oxygen sag in Cutler reservoir. The increment of untreated sugar mill waste from the Malad River augments the organic loading in the lower Bear River and creates a precarious situation for fish and other aquatic life.

7. Phytoplankton in the Bear River below Preston, Idaho, is limited by the screening effect of high turbidity. Plankton in the upper Cub River and Worm Creek is largely composed of normally attached forms which have been detached and carried downstream by the current. In the lower reaches of the Cub plankton blooms develop each year. The responsible organisms are tolerant to pollution and some of the same species are to be found in tanks and filters of sewage treatment plants.

8. The Bear River from Preston, Idaho, to Cutler reservoir is a virtual biological desert insofar as bottom life is concerned. This

is attributed primarily to the excessive siltation with attendant effects. Below Cutler reservoir, siltation is still serious and pollution is severe in late fall, but some forms of bottom life with short life cycles are able to survive.

9. Cub River and Worm Creek support good populations of aquatic invertebrates in their upper and middle reaches, but gross pollution in the lower 10-15 miles of each stream limits productivity and eliminates all but the most hardy species.

10. The trout fishery in the lower 92 miles of the Bear and the lower stretches of the tributaries has been virtually eliminated by organic and inorganic pollution. The successful re-establishment of a channel cat fishery in the Bear River below Cutler dam is contingent upon control of stream flow and of the seasonal pollution.

SOURCES OF POLLUTION

Siltation

The 1952 report of the Public Health Service includes a brief statement on the serious problem of erosion on "Five-Mile" and "Deep" Creeks west of Preston. These streams enter the Bear from the west at miles 88 and 90, respectively. The erosion has been caused by irrigation practices which have raised the water table and caused seepage from embankments of the light, sandy deposits overlying impervious clay strata.

According to H. A. Einstein, consulting engineer retained by the Utah Power and Light Company for a study* on siltation of the Bear River, in the years 1910-1950, 10,000,000 tons of sandy sediment have been eroded from the tributary banks and washed into the Bear River. Bear River channel is silted almost uniformly to a depth of 5-6 feet from the profile of 37 years ago. Most of the material has come from "Five-Mile" Creek and the major damage is downstream from this point 30 miles into Utah to the Cub River pumping plant. Some of the silt has also settled in Cutler reservoir, but only the finest material has been carried beyond the reservoir. As to particle-size, 80 percent has been found to be between 0.1 and 0.3 millimeters, which is fine sand, readily settleable.

Organic Pollution

The report of 1952 contains a detailed table of pollution sources which includes BOD population equivalents, treatment needs and current status of municipal action. The following table (1) is an abridgement of the original with only the more significant sources listed. Moreover, changes in status of treatment over the last two years are included.

* Report on file in the office of the Soil Conservation Service, Portland, Oregon.

The tables indicate that the combined waste from all the industries listed has an aggregate BOD loading as discharged to the receiving waters of almost thirty times that of the municipal sanitary waste. Of the nearly 11,000 people served by sewers in the towns of the lower Bear watershed, less than half--Preston, 4,000--have adequate treatment for their wastes. The remainder need new plants, replacements or enlargements to existing plants.

With regard to the industrial wastes, 92 percent originate from the three sugar refineries, 7.5 percent from two vegetable canneries, and the remainder from small cheese factories, meat packing establishments, etc. These major industries are of a seasonal nature. The only treatment provided is fine screens in the case of the Franklin cannery of California Packing Company. Otherwise, all the major industrial wastes are discharged without treatment. The sources and magnitude of municipal and industrial pollution are illustrated by figure 1 (Appendix).

TABLE 1
BASIC DATA ON SOURCES OF INDUSTRIAL POLLUTION
(Bear River Watershed - Preston to Great Salt Lake)

Name and Location	Industry	Type Waste Produced	Treatment or Other Pollution Control Measure			P.E.(BOD) Discharged to Streams	Pollution Abatement Needs	Current Action	Receiving Stream
			Degree	Cap'y	Opr.				
<u>Bear River</u>									
Cache Valley Dairy Assn, Amalg, Utah	Food	Organic	None	-	-	2,400	New plant	None	Bear Riv.
Calif. Packing Co., Smithfield, Utah	Food	Organic	Minor	Undet.	Undet.	35,200	Undet.	None	Bear Riv.
<u>Cub River</u>									
Calif. Packing Co., Franklin, Idaho	Food	Organic	None	-	-	17,800	New plant	None	Cub Riv.
Amalgamated Sugar Co., Lewiston, Utah	Food	Organic	Minor	Undet.	Undet.	208,000	Undet.	None	Cub Riv.
Sego Milk Co., Richmond, Utah	Food	Organic	None	-	-	2,260	New plant	None	Cub Riv.
<u>Worm Creek</u>									
Franklin Sugar Co., Whitney, Idaho	Food	Organic	None	Undet.	Undet.	212,000	Enlarge-ment	None	Worm Creek
<u>Malad River</u>									
Utah By-Products Co., Garland, Utah	Food	Organic	Minor	Undet.	Undet.	130	Undet.	None	Malad Riv.
Utah & Idaho Sugar Co., Garland, Utah	Food	Organic	Minor	-	-	200,000	Undet.	None	Malad Riv.
Allen Meat Co., Tremonton, Utah	Food	Organic	None	-	-	250	New plant	None	Malad Riv.

TABLE 1 (cont'd)
BASIC DATA ON SOURCES OF MUNICIPAL POLLUTION
(Bear River Watershed - Preston to Great Salt Lake)

Name and Location	Population Served by Sewers	P.E. (BOD) Untreated Wastes	Waste Treatment Provided	P.E. (BOD) Discharged to Watercourse*	Treatment Needs	Receiving Stream
Bear River City, Utah	100	100	None	100	New plant	Bear River
Corinne, Utah	500	500	None	500	New plant	Bear River
Leviston, Utah	500	500	None	500	New plant	Cub River
Preston, Idaho	4,000	4,000	Primary	2,600	None	Worm Creek
Garland, Utah	900	900	None	900	New plant	Malad River
Bear River High School, Utah	1,200	600	Septic tank	550	Replace	Malad River
Tremonton, Utah	1,600	18,000	Septic tank	17,850	Replace	Malad River
Malad, Idaho	1,900	1,900	Primary	1,425	Enlarge	Deep Creek to Malad River

*Includes industrial waste discharged into municipal sewers.

Methods

Physical and chemical analyses at the various stream sampling points were made in accordance with "Standard Methods for the Examination of Water and Sewage," 9th edition. A limited number of "dwarf" plankton or nannoplankton samples were collected, preserved by the addition of concentrated formalin, and concentrated by means of a Foerst type continuous centrifuge. The other plankton samples were qualitative. They were collected by means of a #20 mesh silk bolting cloth tow net. Duration of towing periods was three minutes in each instance, but variations in velocity of flow precluded quantitative determinations.

Quantitative samples of bottom fauna were collected in pools and slow runs by using Ekman or Petersen dredges, depending upon firmness of the bottom. Riffle samples were collected by means of the square foot bottom sampler with #38-mesh trailing net. Qualitative collections were made with a 40x30 inch, 38-mesh reconnaissance screen. Fish collections were by 10-foot seine with one-quarter inch mesh. Wherever feasible, adult winged insects were collected from bushes and other vegetation near the water's edge by means of a beating net. The designation of sampling stations is based upon river mileages measured from the mouth of each stream in question. Table 2 shows the stations from which collections were made for the biological investigations.

TABLE 2
RIVER MILEAGES AND STATION LOCATIONS

Previous Sta. No.*	Sta. No. Based on River Mileage above Stream Mo.	Location
<u>Bear River</u>		
B-31	B-12	Bridge on U.S. Hwy. 30S at Corinne, Utah
	17	Malad River enters
B-33	B-40.5	Cutler Dam--sampling point immediately below dam.
	50	Little Bear River enters
B-32	B-55	Bridge west of Smithfield, Utah
	62	Cub River enters
	72	Idaho-Utah State Line
	80.8	Weston Creek enters from west
	88	Five Mile Creek enters from west
	90	Deep Creek enters from northwest
B-25	B-92	Bridge on U.S. Hwy. 91 north of Preston-- Upstream control station.
<u>Malad River</u>		
B-30	M-11	Tremonton, Utah
	14	Garland, Utah
	M-22	Upper control station; 2 miles north of Riverside, Utah.
<u>Cub River</u>		
	C-1.5	Hodges Road
B-27	C-10	Bridge southwest of Merrills, Utah
16	C-12	Above Lewiston Sugar Mill
	13.5	Worm Creek enters
11	C-19.5	Bridge west of Franklin, Idaho
	20	California Packing Co.
B-28	C-21	First upstream control station; above Franklin
B-26	C-25	Second upstream control station; Mapleton, Idaho
<u>Worm Creek</u>		
10	W-2	Fairview crossing
	7	Franklin Co. Sugar Mill
5	W-8	Preston sewage treatment plant
	15	Lower end of Worm Creek Reservoir
3	W-17	First bridge above Worm Creek Reservoir
	W-19	Upstream control station; lower end of canyon

*Used to designate stations on Tables 3 and 4 which originally appeared in trip reports. All subsequent tables employ station numbers based on stream mileages.

Physico-Chemical Features (See Tables 3 and 4)

Bear River in November was roughly 5° F warmer in its lower reaches than above Preston because of higher turbidity and discharge of warm wastes. The highest (72° F) temperatures recorded in August were at B-92 and M-22. The lowest (59°F) temperature was at W-19.

Turbidity in November was less than 7 ppm at the upstream control stations on Bear and Cub Rivers, W-17 on Worm Creek, and above and below Franklin on Cub River. The latter represents conditions with the California Packing Co. shut down for the season.

The highest turbidity found was 2000 ppm immediately below the sugar refineries at W-10 and M-11, Worm Creek and Malad Rivers, respectively. Turbidity in the Malad above Garland at M-22 was higher than the Cub below Franklin Sugar Co. or the Bear at Corinne. This is attributed to erosion and other pollution from the upper Malad basin.

In August, the uppermost stations on the Worm and Cub were the only stations with turbidity so low as to be immeasurable on the tape. The effect of the cannery at Franklin, which was processing green beans at that time, was shown by turbidities of 68 ppm at C-19.5 and 80 ppm at C-10. Both of the stations on the Malad River had high turbidities in August despite the inactivity of the sugar mill at Garland-- 170 and 180 ppm-- but the Bear River at Corinne was higher still with 200 ppm.

The high methyl orange alkalinity at B-92 on the Bear and W-19, Worm Creek, in November indicates high soluble salt content of the soil formations and water strata draining to these streams. A comparison

of W-19 to W-17 in November shows a discrepancy in the analytical results from these two closely spaced stations that cannot be interpreted without further investigation. The marked increases in alkalinity at W-2 and C-12 are attributed to wastes from the sugar refineries on Worm Creek and Cub River. However, the lower Bear River at B-12 indicates only a 4 ppm increase in alkalinity in November over August.

Dissolved oxygen values in August approached the critical range (under 5 ppm) only at C-19.5 where a test at 7:10 a.m. showed 3.7 ppm. In contrast, there were several sections of critical oxygen values or actual depletion recorded in November, largely as a result of the beet sugar wastes. Most seriously affected in this regard are the lower reaches of Worm Creek and the Cub River. Almost the entire lower ten miles of the Cub lacked dissolved oxygen in November.

The Bear River below the entrance of the Cub undergoes a marked sag in dissolved oxygen which, presumably, reaches a low point in Cutler reservoir and then increases as the stream flows toward Corinne and the marshes. Below the Cutler dam in the backwater stream, the dissolved oxygen was 3.7 ppm on November 11 and 6.4 ppm at B-12 on that same date. Upon conversion to percent saturation, these are 31 and 55 percent, respectively.

TABLE 3
Physico-Chemical Results Determined on Reconnaissance of
Bear River System - Idaho-Utah - August 11-14, 1954

Station	Stream	Date	Water Temp. of	Air Temp. of	Turb. ppm	pH	D.O.	CO ₂ ppm	M.O. Alk. ppm	Phen. Alk. ppm
B-25	Bear R.	8-11	72	86	13	8.6	10.1	0	304	0
3	Worm Cr.	8-11	65	70	50	8.2	7.1	1.5	132	0
5	Worm Cr.	8-12	59	79	0	8.4	10.6	14.0	--*	0
10	Worm Cr.	8-12	67	84	55	8.4	9.4	2.0	--*	0
B-26	Cub R.	8-12	61	85	0	8.6	8.5	0	--*	--*
B-27	Cub R.	8-12	66	84	80	8.6	4:45 pm 9.25	5	--*	--*
B-28	Cub R.	8-13	70	81	16.5	8.5	7:30 am 7.5 1:00 pm 10.6	0	--*	--*
11	Cub R.	8-13	62	63	68	8.2	7:10 am 3.7 9:00 am 4.15	4.0	--*	--*
B-29	Malad R.	8-14	72	84	170	8.6	6.7	14.0	330	0
B-30	Malad R.	8-14	70	86	180	8.4	8.0	15.0	305	0
B-31	Bear R.	8-14	70	84	200	8.4	9.4	4.0	330	0

*Not determined - ran out of 0.02N sulfuric acid for titration.

TABLE 4
Physico-Chemical Results Determined on Reconnaissance of
Bear River System - Idaho-Utah - November 9-12, 1954

Station No.	Stream	Date	Time	Temp. °F		Air	Turb. ppm	pH	D.O. ppm	CO ₂ ppm	M.O.	
				H ₂ O							Alk.	ppm
B-25	Bear R.	11-9	8:00 am	40		40		8.4	9.3	0	350	
3*	Worm Cr.	11-9	10:15 am	38		46		8.2	11.8	2.5	157	
5*	Worm Cr.	11-10	11:00 am	40		54		8.4	11.3	6.	369	
10*	Worm Cr.	11-10	9:15 am	50		44	2000	7.4	0	30.	750	
B-26	Cub R.	11-9	1:00 am	42		62		7.6	12.3	0	172	
B-27	Cub R.	11-10	2:35 pm	52		56	110	8.8	0.8	14.	364	
B-28	Cub R.	11-9	2:50 pm	45		60		8.6	17.7	0	248	
11*	Cub R.	11-9	4:45 pm	40		37		8.6	13.7	0	250	
16*	Cub R.	11-10	10:15 am	48		50	90	7.4	0	20	500	
B-32	Bear R.	11-11	10:45 am	48		58	32	8.6	8.8	0	364	
B-33	Bear R.	11-11	2:35 pm	47		58		8.4	3.7	8	312	
B-31	Bear R.	11-11	5:25 pm	48		60	**	8.4	6.4	**	334	
B-29	Malad R.	11-12	10:30 am	52		52	75	8.4	8.3	0	***	
B-30	Malad R.	11-12	9:25 am	54		50	2000	8.6	4.1	0	396	

* Stations established on former investigation by Utah and Idaho Health Departments.

** Too dark to make satisfactory determinations.

*** Excessively high-color interference.

BIOLOGICAL FEATURES

Plankton

A limited number of plankton samples were collected in August 1954 from the Bear and Cub Rivers; a larger number of samples were collected in November. Table 7 (Appendix) shows the results of the four tow net hauls of August from widely separated stations on the Bear River and from above and below major sources of pollution on the Cub River.

The microscopic examination of water for the determination of plankton was undertaken for two principal reasons: (1) To detect and measure pollution through the use of indicator organisms among the plankton, and (2) recognizing the importance of plankton in the aquatic food chain which culminates in fish, a study of the plankton leads to a better understanding of the deleterious effects of high turbidity and pollution by organic wastes on aquatic life.

Plant planktons were predominant in the Bear at the upstream control station, B-92, but animal plankton supersedes the plants in the lower reaches of the Bear as shown by the results at B-12. This is attributed to adverse effects of turbidity which screens out the sunlight. The minute animal plankters at B-12 were largely rotifers which are a little larger than most single-celled protozoans. Most abundant were the members of the genus Brachionus, a group which tolerates organic pollution. There were nine genera and species of rotifers found at this station--the most varied group of animals found anywhere on the river system.

The clearer waters of the Cub River in August supported a more nearly balanced fauna and flora. The short time of flow from the headwaters to station C-21 above Franklin prevents development of many animal

plankters which have longer life histories than the plant plankters. Thus it is seen that the predominant organisms at C-21 are diatoms (plants), but at C-10 near Merrills, Utah, twelve kinds of zooplankters (animal) have entered the population in this eleven-mile distance of stream. There has also been an increase in numbers and species of green and blue-green algae. Additions of treated and untreated sanitary and industrial wastes from Franklin and via Worm Creek to the lower Cub are also responsible for the marked change in the plankton seen at C-10 and C-1.5. Most noteworthy of pollution tolerant organisms are Pediastrum Boryanum, a green alga, Oscillatoria spp., blue-greens, Brachionus calyciflorus, a rotifer, and Trachelomonas volvocina, a minute "whip-bearer" or flagellate protozoan. Oscillatoria and the latter flagellate are commonly found residing in the upper part of sewage plant trickling filters.

The results of the tow net samples for August and November are summarized in Tables 8 and 9. The former represents the main stem of the Bear, the latter, the tributaries. Out of the total of 56 genera and species found in all samples, 11 or 12 of the more common and consistently occurring organisms are presented in the tables.

The normal increase in numbers of diatoms expected in autumn is shown at B-92 on the Bear. This is in response to the lowered temperature which favors diatom growth. The effect of pollution on the Cub and Worm with particular reference to wastes from the sugar refineries is clearly indicated by the occurrence of sewage fungi and zoogloal colonies in all samples which were collected below the major sources of these refinery wastes. Attention is directed particularly to stations W-8, C-1.5 and M-22 on Table 9 and B-55, B-40.5 and B-12 on Table 8.

Although the heavy concentration of beet pulp fragments at C-10 on the Cub River and at W-2 on Worm Creek prevented successful collection of tow net samples, observations and the collections of bottom fauna indicated extensive growths of sewage fungi and zoogloal at these stations. The tow samples at the other stations farther downstream represent masses of these bacteria and fungi that were drifting downstream.

The fungi, normally, grow attached to some object or to the bottom and slough off into the current as their rapid growth proliferates the colony mass to the point where it can no longer withstand the pull of the current.

Experience has also shown that Sphaerotilus spp., sewage fungi, can grow in very low concentrations of certain wastes, particularly when there is a suitable ratio between carbohydrates and protein-amino acids. The occurrence of these fungi and zoogloea in plankton samples from the Bear River at B-55, at B-40.5 below Cutler dam, and at Corinne, Utah (B-12) in November (Table 10), bears out the field observations made at that time. It was noted that samples of river water from these stations foamed actively when agitated and emitted the sweetish, acrid odor of sugar wastes.

Pollutional animals and plants such as Paramecium sp., other ciliate protozoa, and Euglena viridis followed a pattern of occurrence similar to the sewage fungi and zoogloea. Although the rotifers of the genus Brachionus were also tolerant to pollution, the colder water temperature had caused many of them to become dormant as "winter eggs." This is a normal occurrence and is not attributable to the seasonal pollution of the streams.

Bottom Fauna

All living things are sensitive to changes in their environment. Changes in food supply, light, dissolved gases, and chemical substances in the aquatic environment affect plants and animals living free in the water, attached to, or living on or in the bottom deposits. Characteristics

of, and changes in, an aquatic environment may be evaluated by making chemical and physical tests of the waters. Knowing this, it is possible to predict the type of organisms that may occur. Conversely, a knowledge of the living organisms which occur will permit a classification of the environment.

By the process of sedimentation, silt and debris are constantly being deposited on the bottom. In the case of organic matter in polluted streams, this sedimentation process shifts the scene of natural purification from the water to the stream bottom, where decomposition is continued and scavengers begin their work. The organisms which find the environment favorable will serve as an index to the condition of the stream. Other organisms, less tolerant to resulting lowered oxygen content and possible presence of toxic substances over the deposits, will either migrate or die. The ecological system of Kolkwitz and Marsson as presented by Fair and Whipple in their "Microscopy of Drinking Water" (1927) was used as a basis for the interpretations which follow.

The results of analyses of bottom fauna are presented in Figures 2 and 3 and Tables 11 through 14 in the appendix. Tables 11 and 14 present the results of tests in riffles; 12 and 13 are results from pools and runs. Differentiation of these types of samples is also made on the maps by means of appropriate labels on the pie diagrams. Owing to high flows in the Bear River in August, quantitative collections from Sta. B-92 were impractical. Results from this upstream control station are therefore based on collections made in November. The pie diagrams on Worm Creek in August are based upon qualitative data provided by Gaufin,

hence the proportions of polluttional to facultative to clean organisms are approximations.

Bear River, Main Stem: (Tables 11 and 12 and Figure 3) - The composite of the riffle samples from B-92 in November indicates productivity in Grade 1 class (rich)* with 2.13 grams of organisms per square foot. There were only 2 percent polluttional organisms and 13 species, genera or families of organisms. This indicates a healthy, clean environment. In contrast, the downstream sampling points on the Bear demonstrate the adverse effect of inorganic and organic pollution. Productivity drops to a trace at Smithfield (B-55) and at Corinne (B-12); speciation or numbers of kinds of organisms drops to 2 - 4. Effect of organic pollution from the sugar refineries is shown at B-55 and B-12 in November with 80 and 63 percent polluttional indicator organisms respectively.

Malad River: (Table 12 and Figure 3) - In November the Malad River at M-22, the upstream control point, indicated low productivity, little diversification of organisms and less than one-half of the organisms polluttional-tolerant. This is attributed to the rigorous environmental conditions of high turbidity, unstable mud and silt bottom, and very high dissolved salt concentration of the water. Addition of beet sugar refining wastes at Garland with attendant sludge deposits downstream creates conditions which are satisfactory for growth of large numbers of sludge worms and a few midges. Total productivity is average with 1.6 grams per square foot; speciation is of low order with only two kinds of organisms and 98.5 percent of these in the polluttional category.

*Davis, H. S. "Instructions for Conducting Stream and Lake Surveys", Fishery Circular No. 26, U. S. Department of Commerce, Bureau of Fisheries, 1938.

Worm Creek: (Figures 2 and 3, Table 11) - Because of water storage in Glendale Reservoir immediately below W-17 and irrigation diversions, flow in Worm Creek during the late summer and fall is practically nil above the Preston sewage treatment plant. Flow at W-2 in August therefore is composed largely of the partially treated sewage from Preston plus some irrigation return flows.

Reference is made to the field observations (Table 6) in relation to the upstream control station W-17 and W-19 on the Worm. In November large numbers of stonefly nymphs were found at W-17. These are good examples of clean water organisms. The large component of pollutional organisms in the August sample from W-8 (above treatment plant) is attributed to the heavy deposits of decaying organic matter washed from the land.

The so-called riffle at W-2 is a stretch of uneven hardpan clay over which the water moves rapidly. Attachment surfaces in this reach for most bottom fauna is presumed to be unsatisfactory. The results which are reported for August and November indicate gross pollution in Worm Creek within one and a half miles of the Idaho-Utah line. In August the conditions found at W-2 are attributed to low flows, irrigation returns and primary effluent from the Preston sewage treatment plant. In November the increase in volume of flow and pollution load from the sugar beet refinery at Whitney, a short distance south of Preston, causes such severe scouring of the bottom that samples of bottom fauna are not entirely satisfactory. Aside from a few specimens of damsel fly nymphs which had probably been washed down from some upstream point, the only bottom organisms found were a few pollution-tolerant sludge worms, Limnodrilus sp.

Cub River: (Figures 2 and 3, Tables 13 and 14) - Results of bottom faunal collections indicate clean stream conditions above Franklin, Idaho, with some modification of natural stream conditions from irrigation diversion. Stations C-25 and C-21, the two upstream control stations, had rich growth in the riffles with up to 8.0 grams per square foot at C-21 from 2.0 grams minimum at C-25.

Speciation was high with largest number of kinds (15) found at C-25. There were insignificant numbers of pollutional organisms. The 73 percent of pollutional organisms from the pool at C-21 represents scavengers that were feeding on the decaying algae, fertile soil wash, and other organic matter settled in the pool at this station.

The results of bottom faunal tests at C-19.5 in August reflect the serious condition of pollution in the Cub River below Franklin. Percent of pollutional indicator organisms increases in the riffles from a maximum of 3.25 above Franklin to 100 percent below Franklin. Speciation decreases from 15 to 2, maximum range, while total numbers of organisms increase by nearly a thousand, 2714 - 3488. Most of the increase at C-19.5 is made up by red midges and sludge worms. A similar situation exists in the pools at these two stations in August, but with lower productivity in the pools. Total numbers of red midges and sludge worms in November at C-19.5 was nearly doubled over numbers in August - 8550 per square foot.

The continued indication of severe pollution in November at this station was caused by lingering sludge deposits from the operation of the California Packing Plant in the late summer and early fall.

Stream conditions at C-10 in August indicated partial recovery from pollution by cannery wastes, particularly in the riffles. The pools at C-10 in August contained principally red midges and sludge worms, indicating decaying organic matter from upstream sources. Recovery in the riffles is shown by moderate speciation (10 kinds) and only 6 percent pollution-tolerant organisms. Total productivity was low - 0.85 gm. per square foot - owing to the "pollutional blanket" of blue-green algae.

In November the combined wastes from beet sugar mills at Whitney, Idaho, and Lewiston, Utah, in addition to Preston's treatment plant effluent and other minor sources, produce severe and rigorous conditions of existence for bottom fauna at C-10. As indicated in Table 6, the flow was so high and fast that this reach resembled the tail race of a power plant. Violent agitation and short-time of flow from major pollution sources allow for a trace of dissolved oxygen to be present in the water. Consequently a few scuds (2 species) were found to survive. Sludge worms were also found in small numbers. There were only 3 kinds of organisms in trace weight concentration per square foot at this station.

Fish

Despite the wide fluctuation in flow of the Bear River above Preston, trout fishing is reported to be excellent from above Preston to the dam at Oneida. Below Preston the extremely heavy siltation of the river bed, the high turbidity of the water over the past 20-30 years, and pollution have eliminated the trout. A few trash fish, such as carp and

catfish, have been reported from Preston to Cutler reservoir, but a fish population study in the fall of 1954 by the Utah Department of Fish and Game has indicated an absence of fish of any kind at Station B-55, Smithfield, Utah, and only a few carp below Cutler Dam. The results of these investigations in November 1954, on the Bear and Malad Rivers are presented in the following table:

TABLE 5

River	Station	Seining	Stream Shocking	Rotenone Poisoning
Bear	B-55	0	0	0
Bear	B-40.5	-	4-5 carp	-
Malad	M-22	-	0	0
Malad	M-11	-	0	0

The stream shocker was of the direct current type with an aluminum boat utilized as one of the two electrodes. The shocker failed to function in the Malad because of the high concentration of dissolved salts; therefore, rotenone poison was used as a means of determining the population.

The Malad at M-22 had a fair-sized population of mosquito fish, Gambusia, in August, but for some reason these little fish had migrated from the area by late fall.

With regard to the other tributaries, Cub River and Worm Creek, the Cub above Mapleton, Idaho, is reported to have mediocre trout fishing despite the high fertility of the water and abundant production of fish food organisms. The pools in the Cub above Franklin support large populations

of minnows, but no sport species were found in August or November. A few species of minnows and some small carp were collected below Franklin in November and in August. No fish were found in the lower Worm at W-2 in August, though this was at a time when effluent from the sewage plant at Preston was the only major source of waste in the creek.

Discussion

Cold weather and low water temperatures alleviate the severe conditions of pollution downstream from the sugar refineries. Water temperatures in November were in the range at which refrigerators are held; consequently, the septic water from the Cub River was carried a long distance down the Bear River and diluted to such an extent that less than a mile downstream from the mouth of the Cub, or mile 61, the Bear River showed a drop of only 0.2 ppm of dissolved oxygen under that at the Trenton Station, mile 66. At some undetermined point downstream, either above or in Cutler reservoir, the dissolved oxygen drops below the 40% saturation point and the zone of degradation begins, as downstream from the Cutler dam the oxygen was only 31% saturation. At another undetermined point downstream between mile 40.5 and mile 12, the sag curve rises past the 40% mark and partial recovery is presumed to take place.

A significant gap in our knowledge exists in that reach of the Bear from the confluence of the Malad River to the Bear River marshes during and immediately following the season of beet sugar refinery. The long delay in natural purification of untreated wastes from the Cub River, combined with the increment of untreated wastes from the Malad, create a situation of instability in the aquatic environment. This is borne out by results of

the biological investigations in this section. Should the Utah Department of Fish and Game plan to rehabilitate the fishery in this reach, it is recommended that a program of 24-hour sampling for dissolved oxygen and biochemical oxygen demand be undertaken at prescribed points along the lower 40 miles of the Bear River during and immediately following the processing of sugar beets.

APPENDIX

TABLE 6

Field Observations and Descriptions of Aquatic Habitats
at the Principal Sampling Stations

StationBear River

B-92 Upstream control station - Moderate stream bed gradient with riffles, pools and runs. Water quite clear and patches of submerged vegetation occur to provide cover for bottom organisms and small fish. Instability of environment created by wide fluctuation in discharge owing to power dam upstream. This results in limitation of productive areas in riffles.

B-55 Represents stream conditions under combined impact of excessive siltation from Deep and Five-Mile Creeks and organic pollution from Worm and Cub drainage. Riffles smothered under several feet of silt and sand, hence no longer effective in the natural purification processes of the stream. Shifting sand smothers many forms of bottom life and molar action grinds organisms.

B-40.5 Old stream channel receiving seepage from Cutler dam. In November distinctive odor of sugar wastes and pollution blanket on rocks composed of zoogloea and sphaerotilus intermingled with copious growths of green alga, Cladophora sp.

B-12 Below confluence of Malad River - High sedimentation rate and molar action has restricted the environment to a few hardy organisms with short life cycles such as the green midge, Calospectra sp. In November large amounts of mixed sludge and silt were found on bottom. Material easily roiled up and when this occurred, gas bubbles were evolved.

Malad River

M-22 Highly turbid water, muddy banks, muddy, clay bottom. Sixty percent clean water organisms found in August, sparser total population in November

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(Table 6 - Continued)

Malad River (Cont'd)

- M-11 Below sugar refinery at Garland, Utah - Heavy growth of sludge worms up to 2 grams per square foot of bottom. No facultative or clean organisms found in November.

Worm Creek

- W-19 Steep gradient, rocky riffles, few pools, heavy brush along stream banks, almost impenetrable many places. There was much natural cover and although flow in November was estimated at less than 10 c.f.s. conditions of natural food and cover appeared ideal for trout.

- W-17 Above Glendale Reservoir - Farming of the hilly land has caused erosion and resultant silting of pools and riffles. Therefore, only fair productivity and low organic enrichment in Worm Creek this station.

- W-8 Above Preston treatment plant - Typical, slow-moving valley stream with less flow in August and November than at W-17 because of irrigation diversions. Water clear but decaying organic matter lay in pockets on bottom. Margins were grassy and weedy.

- W-2 Stream bed clay and hardpan, no rocky riffles. The stream flowed in a narrow trough with steep banks 30-40 feet in height. There was much overhanging vegetation. Aquatic weed beds, Potamogeton sp., occurred in shallow areas. During sugar refining season this reach is a swift sluiceway of concentrated waste scoured clean of aquatic plants and bottom organisms.

Cub River

- C-25 Mapleton, near lower end of Cub Canyon - Stream about 50 feet wide and of variable depth, from a few inches over rocky ledges to several feet in the pools. Gradient is steep over rubble bed. Willows line the banks.

(Table 6 - Continued)

Cub River (Cont'd)

C-21 Low flow most of year owing to irrigation diversions above. Stream gradient much more nearly flat than C-25. Shallow riffles nearly choked with trailing masses of green algae. Very heavy growth of bottom fauna - caddis-flies, particularly.

C-19.5 Below Franklin - Stream gradient quite flat between this point and C-21, but steepens slightly to provide appreciable riffles at this station. Gross pollution observed during bean pack in August. Heavy sludge deposits lined the pools. A few scattered mayfly and dragon fly nymphs were collected along the stream margins where pollution effects may have been less severe than at midstream. By November, 19.5 indicated progress in recovery, but pools still had deposits of sludge with sludge worms in abundance. These with large number of 2-3 inch crane fly larvae, Holorusia rubiginosa, and some snails grossed a total weight of 41.4 grams per square foot - a record for all collections on the Bear River System.

C-10 In August some recovery from bean cannery wastes accomplished in the 9.5 miles of flow. Heavy "pollution blanket" of blue-green algae and fungi coated rocks in riffles. Only organisms with short life histories found here. In November this station represents condition on Cub below both sugar refineries - Whitney, Idaho, and Lewiston, Utah. Flow was very fast - 5 feet per second - and sewage fungus streamed from bottom and submerged objects. Riffles observed in August were submerged in November. Stream resembled a tail race from a power plant.

TABLE 7

Bear River System
Plankton - Results of Tow Hauls
August 1954

A - Abundant
C - Common
O - Occasional

R - Rare
Pred. - Predominant

Organisms	Location			
	Bear River		Cub River	
	Above	Below	Above C-21	Below C-10
	Preston	Melod R. Jet	Franklin	Merrills
<u>Blue-green algae</u>				
Oscillatoria (large sp.)	O			O
Oscillatoria (small sp.)	O		O	
<u>Green Algae</u>				
Actinastrum Aantzschii	O	O		O
Ankistrodesmus falcatus				R
Cosmarium sp.	O			O
Crucigenia sp.			O	
Pediastrum Boryanum	C	C		A
Pediastrum duplex	O	O		C
Scenedesmus quadricauda	C	C		C
Sphaerocystis Schroeteri		R		
Spirogyrasp		R		
<u>Diatoms</u>				
Amphora ovalis	C		C	
Cocconeis pediculus	O			
Cocconeis placentula	C			
Cocconeis sp.			C	C
Cyclotella sp.	C	O		
Cymatopleura solea	O			O
Diatoms vulgare	C			
Gomphonema acuminatum	C		A	C
Gyrosigma sp.	O	O		
Melosira spp.	O	O		C
Navicula			A	
Nitzschia spp.			C	
Synedra spp.	C	C		
Cymbella sp.	R			
<u>Protozoa</u>				
Ceratium hirundinella	O	O		
Eudorina elegans		R		O
Euglena sp.			O	

(Continued)

(Table 7 - Continued)

Organisms	Location			
	Bear River		Cub River	
	Above	Below	Above C-21	Below C-10
	Preston	Malad R. Jet	Franklin	Merrills
<u>Protozoa (Cont'd)</u>				
Gymnodinium sp.	R	O		
Pandorina morum		R		R
Stentor sp.		R		
Trachelomonas volvocina				C
Vorticella sp.	O			O
<u>Rotifers</u>				
Asplanchna sp.		O		O
Brachionus angularis		C		
B. calyciflorus		C		C
B. capsuliflorus		O		
B. caudatus		O		
B. patulus				R
B. quadridentata		O		
Bdelloid rotifers				O
Euchlanis sp.				O
Filinia longiseta				R
Keratella cochlearis		O		
Pedalia sp.		R		
Polyarthra trigla		O		O
<u>Other organisms</u>				
Cladocera		O		O
Bosmina sp.		R		
Daphnia sp.				R
Nauplii				O
Cyclops sp.				
Nematodes			R	

TABLE 8
Summarized Results of Tow Net Plankton from Bear River
August and November 1954

Organism	B-92	B-55	B-40.5	B-12
	8-11	11-9	11-11	11-11
<u>Green Algae</u>				
Spirogyra				
Cladophora				
<u>Diatoms</u>				
Diatoma vulgare	C*	A	A	C
Melosira	O	A	A	O
Surirella				C-A
<u>Protozoa</u>				
Ciliates			C	C
Euglena viridis				C
Paramecium				
<u>Rotifers</u>				
Brachionus spp.			C**	C
<u>Other</u>				
Sphaerotilus		C	A	A
Zoogloea		C	A	A

*C - Common; A - Abundant; O - Occasional; R - Rare
**Encystment or winter egg stage starting.

TABLE 9
Summarized Results of Tow Net Samples from Bear River
Tributaries - August and November 1954

Organism	: W-8 : : 11-10 :	: C-21 : : 8-13 :	: C-10 : : 11-9 :	: C-1.5 : : 8-12 :	: M-22 : : 11-10 :	: M-22 : : 11-12 :
<u>Green Algae</u>						
Pediastrum Boryanum			A			
Spirogyra sp.	A					
<u>Diatoms</u>						
Diatoma vulgare	C	A	A		O	
Navicula spp.		A			R	
Surirella spp.					A	
Melosira spp.	C			C		
<u>Protozoa</u>						
Euglena viridis			R			
Paramecium sp.					C	
Trachelomonas volvocina				C	C	
<u>Rotifers</u>						
Brachionus spp.			R			
<u>Others</u>						
Sphaerotilus	O				A	
Zoogloea	O				A	

TABLE 10
Biological Data - Tow Net Hauls
Bear River System
November 9-12, 1954

A - Abundant
C - Common R - Rare
O - Occasional Pred. - Predominant

Organism	Station								
	B-92	B-55	B-40.5	B-40.5	B-12	W-8	C-21	C-1.5	M-22
<u>Blue-green algae</u>									
Oscillatoria sp.		O							
<u>Green Algae</u>									
Cladophora sp.				A					
Closterium moniliferum			R						
Cosmarium sp.				R					
Oocystis sp.				R					
Pediastrum Boryanum		O	O	R	R				
Pediastrum duplex		R							
Scenedesmus quadricauda	R	O	O	R	R				
Spirogyra sp.						A			
Staurostrum sp.	O	R							
<u>Diatoms</u>									
Achnanthes sp.							R		
Amphiprora sp.						O			O
Amphora ovalis							R		
Cocconeis pediculus				R	C		C		
Cocconeis placentula			O						
Cyclotella sp.				O					
Cymatopleura solea				R	R	R			O
Cymbella sp.	O								
Diatoma vulgare	A-Pred.	A-Pred.	C	A	R-O		R		O
Diatoma sp.							A-Pred.	O	
Epithemia sp.	O		R	O		C			
Gomphonema acuminatum	O	R							O
Gyrosigma					O	R	C		O
Melosira sp.	A-Pred.	A-Pred.	O	R	O				O
Navicula		O	O	C	C-A				
Nitzschia spp.	O	O	O	C	C	C		R	A
Surirella sp.				R			C		C
Synedra spp.	O	O	C	C	O		R		A-Pred.
Tabellaria sp.		R				O	C		C
<u>Protozoa</u>									
Amoeba sp.									
Chlamydomonas sp.		O						R	
Ciliates			C		C				
Codonella cratera	O	O	R	R					
Colpidium sp.		R		R					
Diffugia sp.						R			

TABLE 10 (cont'd)

Organism	Station								
	B-92	B-55	B-40.5	B-40.5	B-12	W-8	C-21	C-1.5	M-22
Dinobryon sertularia	R								
Euglena viridis		C			C			C	
Euglena spp.								C	
Euplotes sp.				O					
Gymnodinium sp.			R						
Pandorina morum	O								
Paramecium sp.								C	
Phacus				R					
Pleuronema sp.				O			R		
Synura uvella	R								
Vorticella sp.			R				R		
<u>Rotifers</u>									
Asplanchna sp.	O				O		R		
Brachionus angularis		O	C						
Euchlanis sp.				O					
Keratella cochlearis	O	O	R						
Lecane luna							R		
Polyarthra trigla	R								
<u>Miscellaneous</u>									
Cyclops sp.							R		
Nauplii									
Sphaerotilus		C	A-Pred.	A	A-Pred.	R		A	C
Zoogloea		C	A-Pred.	C	A-Pred.	O		A	

TABLE 11
Biological Data
Bottom Fauna - Rifle Samples
Bear River System - August and November 1954
Numbers per square foot of bottom surface

Organisms	Bear B-92 11-9-54	Worm W-17 11-9-54	Worm W-2 11-10-54
<u>Diptera - True Flies</u>			
<u>Tendipedidae</u>			
Green	204		
<u>Simuliidae</u>	775		
<u>Eriocera sp.</u>		10	
<u>Ephemeroptera - Mayflies</u>	50		
<u>Coleoptera - Beetles</u>			
<u>Elmidae</u>	8		
<u>Lepidoptera - Water Moths</u>			
<u>Elophila Sp.</u>	2		
<u>Odonata - Dragon and Damselflies</u>			
<u>Enallagma sp.</u>			4*
<u>Plecoptera - Stoneflies</u>	2	275	
<u>Trichoptera - Caddis Flies</u>			
<u>Brachycentridae</u>		1	
<u>Hydropsychidae</u>	168		
<u>Crustacea</u>			
<u>Gammarus sp.</u>	3	2	
<u>Hyalella azteca</u>			
<u>Oligochaetes - Aquatic Worms</u>			
<u>Limnodrilus sp.</u>	6	20	8
<u>Pelosciolex multisetosus</u>	5		
<u>Tubifex tubifex</u>	2		

*Washed down from point upstream - eliminated.

TABLE 11 (cont'd)

Organisms	Bear B-92 11-9-54	Worm W-17 11-9-54	Worm W-2 11-10-54
<u>Hirudinea - Leeches</u>			
<u>Glossiphonia sp.</u>	6	2	
<u>Glossiphonia stagnalis</u>	3		
<u>Total</u>	1234	310	12
<u>Weight Grams/sq. ft.</u>	2.13	1	Trace
<u>Percent Pollutational</u>	2	7.1	100
<u>No. species, families, etc.</u>	13	6	1

TABLE 12
Biological Data
Bottom Fauna - Pool and Run Samples
Bear and Maled Rivers
Numbers per square foot

Organisms	Bear B-55 11-11-54	Bear B-12 8-14-54	Bear B-12 11-11-54	Maled M-22 11-12-54	Maled M-11 11-12-54
<u>Diptera - True Flies</u>					
<u>Tendipedidae</u>					
Small Green Tend.			13	6	3
Calospectra sp.		224		7	
Spaniotoma sp.	1		16	9	
Tendipes decorus					
<u>Oligochaetes</u>	4		2		215
Limnodrilus spp.			4		A
Nais sp.					0
<u>Leeches</u>		2			
Total	5	226	35	22	218
Wt.-Oz/sq ft	Trace	Trace	Trace	Trace	1.6
Percent Pollutational	80	1	63	41	98.5
No. species, genera-families	2	2	4	3	2

TABLE 13
Biological Data
Bottom Fauna - Pool and Run Samples
Cub River - August and November 1954
Numbers per square foot bottom area

Organisms	C-21 8-13-54	C-21 11-9-54	C-21 11-9-54	C-19.5 8-13-54	C-19.5 11-9-54	C-10 8-12-54	C-10 11-10-54	C-12 11-10-54
Diptera - True flies								
Tendipedidae - Red								
Small green			336		8	36	4	4
Calospectra spp.	26	272	56					
Clinotanyus sp.	16		32	208				
Cryptochironomus sp.	36							
Endochironomus sp.		36						
Microtendipes sp.	8							
Pentapedilum sp.								
Tendipes decorus	2		72	424	184	270		
Holorusia rubiginosa			16		8			
Tabanidae			8					
Coleoptera - Beetles								
Halipilidae	6		8		2			
Phanocerus sp.	2							
Ephemeroptera - Mayflies			4					
Beetidae					4	2		
Plecoptera - Stoneflies		1				28		
Trichoptera - Caddis Flies		4						
Hydropsychidae		16						
Oligochaetes	176				8332		4	
Naididae			1460	620	O*	20		
Nais sp.			160		A			
Limnodrilus spp.								
Pelosciolex multisetosus				84				4
Tubificidae	108							18
Tubifex tubifex								
Leeches	2		8		0			
Glossiphonia stagnalis					2			

TABLE 13 (cont'd)

Organisms	C-21 8-13-54	C-21 11-9-54	C-21 11-9-54	C-19.5 8-13-54	C-19.5 11-9-54	C-10 8-12-54	C-10 11-10-54	C-12 11-10-54
Mollusca - Snails & Clams								
Ferriissidae								
Physa spp.	76	8	8		10			
Sphaerium sp.	4		48					
Pisidium sp.	18		152					
Gyraulus sp.			8					
Crustacea								
Hyalosella azteca							24	
Total	480	337	2380	1336	8550	356	32	26
Wt-Grains/sqft	1.4	Trace	10	2	41	0.2	Trace	Trace
Percent Pollutational	76	7	73	85	99.5	82	100	85
No. species-								
genera-families	13	6	16	4	10	5	3	3
O# - Occasional								
A - Abundant								

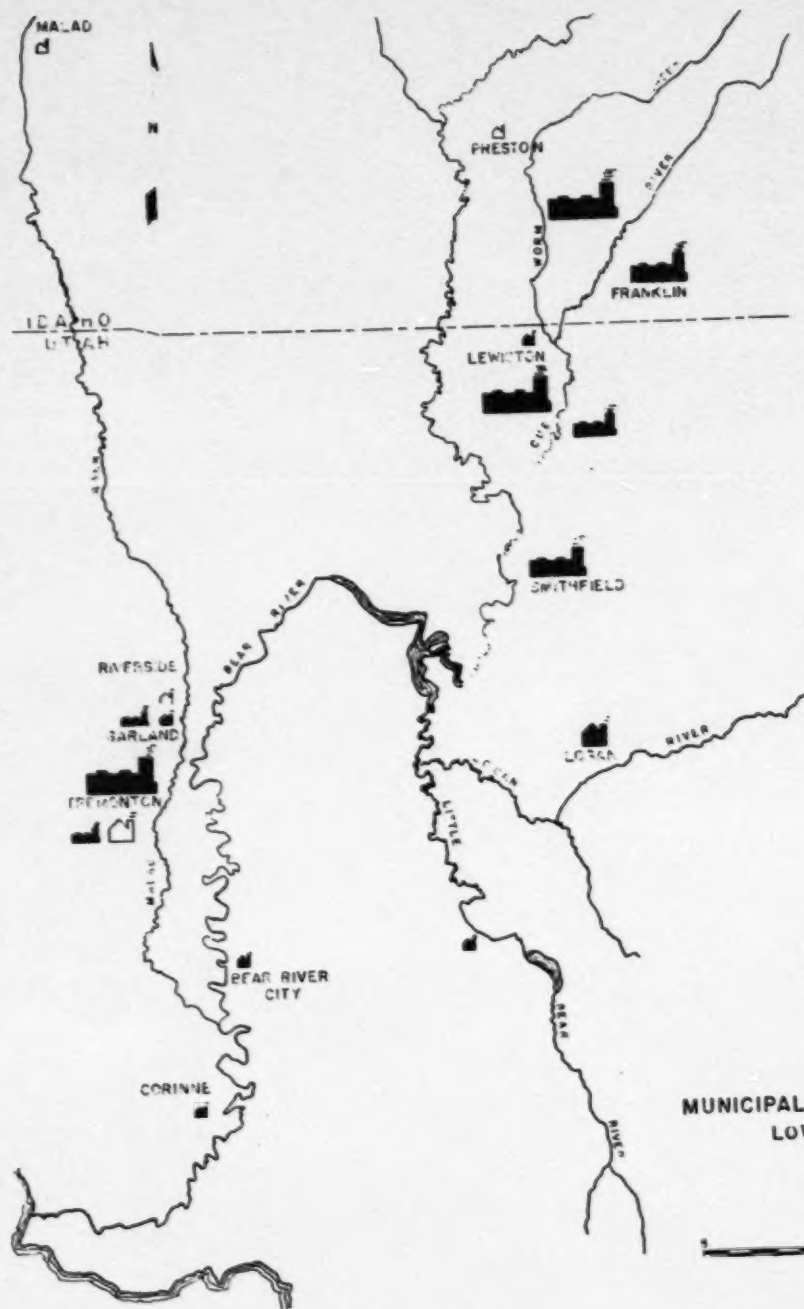
samples for which long pollen counts
 are available - indicate very low pollen
 counts - 1000 or less per sample
 indicating very low pollen
 counts

TABLE 14
Biological Data
Bottom Fauna - Riffle Samples
Cub River - August and November 1954
Numbers per square foot bottom surface

Organisms	C-25 8-12-54	C-25 11-9-54	C-21 8-13-54	C-21 8-13-54	C-21 11-9-54	C-19.5 8-13-54	C-19.5 11-9-54	C-10 8-12-54	C-10 11-10-54
Diptera - True flies	9								
Tendipedidae-Red									
Small green	20		248	262	30	732	13	330	
Calospectra sp.								0	
Clinotanypus sp.						R		0	
Cryptochironomus sp.								A	
Diamesinae									
Spaniotoma sp.		31							
Tendipes decorus		10				A	6		
Tipulidae	3								
Eriocera sp.	1		2				6		
Holorusia rubiginosa									
Limnobiinae		80							
Simuliidae	21				1				
Ceratopogonidae	1								
Coleoptera - Beetles		15						218	
Elmidae	41								
Phanocerus sp.			94	26	2				
Halipilidae				8			1		
Brychius sp.									
Ephemeroptera - Mayflies	300	186			16				
Beetidae	A		147	357					
Heptageniidae	R		98	119			15	2	
Lepidoptera									
Elophila sp.	1	4			2				
Neuroptera									

TABLE 14 (cont'd)

Organisms	C-25 8-12-54	C-25 11-9-54	C-21 8-13-54	C-21 8-13-54	C-21 11-9-54	C-19.5 8-13-54	C-19.5 11-9-54	C-10 8-12-54	C-10 11-10-54
Plecoptera - Stoneflies	18	18	20		2			3	
Trichoptera - Caddis Flies		35	1486		335				
Brachycentridae	139								
Hydropsychidae	11		A		A				
Leptoceridae	2								
Microcaddis	1								
Rhyacophilidae	1								
Oligochaetes-Sludge Worms		2				2756	487	38	6
Neis sp.					1		0	A	
Limnodrilus spp.					1		C	R	
Tubifex tubifex					1		C		
Leeches				4			1		
Glossiphonia sp.									
Snails									
Gyraulus sp.					2				
Physa spp.			3		13		26	1	
Stagnicola sp.							1		
Crustacea									
Gammarus sp.								1	8
Hyalrella azteca									1
Nematodes		1							
Total	569	382	2102	2714	405	3488	556	593	15
Wt in grams/sq-ft	3.28	2.0	7.0	8.0	5.6	4*	6.75	0.85	Trace
Percent polluttional	0	1	0.5	0	3.25	100	94	6	100
No. species,families,etc.	15	10	10	7	11	2	13	10	3
*Estimate									
A - Abundant									
O - Occasional									
C - Common									
R - Rare									



SOURCES OF MUNICIPAL POLLUTION

POPULATION EQUIVALENT (P.E.) OF WASTES
DISCHARGED TO STREAM

- 5000 AND UNDER
- 5000-15000
- 15000-30,000

SOURCES OF INDUSTRIAL POLLUTION

POPULATION EQUIVALENT (P.E.) OF WASTES
DISCHARGED TO STREAM

- 1000 AND UNDER
- 1000-5000
- 5,000-50,000
- 50,000 AND OVER

TREATMENT FACILITIES

- IN EXISTENCE
- NOT IN EXISTENCE

FIGURE 1
SOURCES OF
MUNICIPAL AND INDUSTRIAL POLLUTION
LOWER BEAR RIVER SYSTEM
1954

